

EC2x&UC20

Compatible Design

UMTS/HSPA/LTE Module Series

Rev. EC2x&UC20_Compatible_Design_V1.0

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About the Document

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1 Introduction

Quectel EC2x module contains EC25, EC21, EC20 and EC20 R2.0 variants which are all compatible with UC20. This document briefly describes the compatible design among EC25, EC21, EC20 R2.0, EC20 and UC20, which can help you easily migrate from one to either of the others in your design and manufacturing.

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2 General Descriptions

2.1. Product Description

EC25, EC21, EC20 R2.0, EC20 and UC20 modules have some serial products. The following tables show the frequency bands and module general information.

Table 1: Module Frequency Bands

| Module | LTE | UMTS | GSM | Rx-diversity | GNSS |
|-----------------|---|---|----------|--------------|---|
| EC25-A | FDD: B2/B4/B12 | WCDMA: B2/B4/B5 | | Y | GPS GLONASS BeiDou Galileo QZSS |
| EC25-E | FDD: B1/B3/B5/B7/B8/B20 TDD: B38/B40/B41 | WCDMA: B1/B5/B8 | 900/1800 | Y | |
| EC25-V | FDD: B4/B13 | | | Y | |
| EC25-AUT | FDD: B1/B3/B5/B7/B28 | WCDMA: B1/B5 | | Y | |
| EC21-A | FDD: B2/B4/B12 | WCDMA: B2/B4/B5 | | Y | GPS GLONASS BeiDou Galileo QZSS |
| EC21-E | FDD: B1/B3/B5/B7/B8/B20 | WCDMA: B1/B5/B8 | 900/1800 | Y | |
| EC21-V | FDD: B4/B13 | | | Y | |
| EC21-AUT | FDD: B1/B3/B5/B7/B28 | WCDMA: B1/B5 | | Y | |
| EC21-AUTL | FDD: B3/B7/B28 | | | Y | |
| EC20-C R2.0 | FDD: B1/B3/B8 TDD: B38/B39/B40/B41 | WCDMA: B1/B8 TD-SCDMA: B34/B39 | 900/1800 | Y | GPS GLONASS BeiDou Galileo QZSS |
| EC20-CE R2.0 | FDD: B1/B3/B8 TDD: B38/B39/B40/B41 | WCDMA: B1/B8 TD-SCDMA: B34/B39 CDMA: BC0 | 900/1800 | Y | |




| | | | | | |
|----------------|---------------------------------------|--|-----------------------|---|----------------|
| EC20-C | FDD: B1/B3/B8 TDD: B38/B39/B40/B41 | WCDMA: B1/B8 TD-SCDMA: B34/B39 | 900/1800 | Y | |
| EC20-CE | FDD: B1/B3 TDD: B38/B39/B40/B41 | WCDMA: B1 TD-SCDMA: B34/B39 CDMA: BC0 | 900/1800 | Y | GPS GLONASS |
| EC20-A | FDD: B2/B4/B5/B12/B17 | WCDMA: B2/B4/B5 | 850/1900 | Y | |
| EC20-E | FDD: B1/B3/B5/B7/B8/B20 | WCDMA: B1/B5/B8 | 850/900/ 1800/1900 | Y | |
| UC20-A | | WCDMA: B2/B5 | | Y | |
| UC20-E | | WCDMA: B1/B8 | 850/900/ 1800/1900 | Y | GPS GLONASS |
| UC20-G | | WCDMA: B1/B2/B5/B6/B8 | 850/900/ 1800/1900 | Y | |

NOTE

Y = supported (including LTE and UMTS)

EC25, EC21, EC20 R2.0, EC20 and UC20 are designed as compatible products. You can choose the right module for your applications. Under the help of the compatible design guideline, you can migrate from one to either of the others smoothly during your product design and manufacturing.

Table 2: Module General Information

| Module Name | Picture | Packaging | Dimensions | Description |
|-------------|---|------------------------------|-----------------|--|
| EC25 |  | 80 LCC pads + 64 LGA pads | 29 × 32 × 2.4mm | LTE module (EC25-A, EC25-E, EC25-V, and EC25-AUT) |
| EC21 |  | 80 LCC pads + 64 LGA pads | 29 × 32 × 2.4mm | LTE module (EC21-A, EC21-E, EC21-V, EC21-AUT and EC21-AUTL) |
| EC20 R2.0 |  | 80 LCC pads + 64 LGA pads | 29 × 32 × 2.4mm | LTE module (EC20-C R2.0 and EC20-CE R2.0) |

| | | | | |
|------|---|------------------------------|-----------------|---|
| EC20 |  | 76 LCC pads + 64 LGA pads | 29 × 32 × 2.4mm | LTE module (EC20-C, EC20-CE, EC20-A and EC20-E) |
| UC20 |  | 72 LCC pads + 40 LGA pads | 29 × 32 × 2.5mm | UMTS/HSPA+ module (UC20-A, UC20-E and UC20-G) |

2.2. Feature Overview

The following table compares the general features of EC25, EC21, EC20 R2.0, EC20 and UC20.

Table 3: Feature Overview

| Feature | UC20 | EC20 | EC20 R2.0/EC21/EC25 |
|----------------------------------|---|---|---|
| Power Supply | 3.3~4.3V, Typ.=3.8V | 3.3~4.3V, Typ.=3.8V | 3.3~4.3V, Typ.=3.8V |
| Peak Current | VBAT_BB&RF: max 2.0A | VBAT_BB&RF: max 2.0A | VBAT_BB&RF: max 2.0A |
| Sleep Current (USB Suspended) | 2G: 3.7mA @DRX=2 3G: 3.0mA @DRX=6 | 2G: 3.7mA @DRX=2 3G: 3.0mA @DRX=6 | TBD |
| LTE Features | | Support 3GPP R9 CAT3 FDD: Max 50Mbps (UL), 100Mbps (DL) TDD: Max 18Mbps (UL), 61Mbps (DL) | EC20 R2.0/EC25: Support up to LTE CAT4. Max 50Mbps (UL), Max 150Mbps (DL) EC21: Support up to LTE CAT1 Max 5Mbps (UL), Max 10Mbps (DL) |
| Temperature Range | Operating temperature range: -35°C ~ +75°C ¹⁾ Extended temperature range: -40°C ~ +85°C ²⁾ | Operating temperature range: -35°C ~ +75°C ¹⁾ Extended temperature range: -40°C ~ +85°C ²⁾ | Operating temperature range: -35°C ~ +75°C ¹⁾ Extended temperature range: -40°C ~ +85°C ²⁾ |
| UART Interface | Baud rate: reach up to 921600bps Flow control: RTS/CTS | Baud rate: reach up to 921600bps Flow control: RTS/CTS | Baud rate: reach up to 921600bps Flow control: RTS/CTS |
| USB Interface | USB 2.0 HS (Slave only) | USB 2.0 HS (Slave only) | USB 2.0 HS (Slave only) |

| | | | |
|------------------|-------------------------|-------------------------|---------------------------------------|
| Digital Audio | PCM interface | PCM interface | PCM interface |
| I2C Interface | Supported | Supported | Supported |
| USIM Detection | YES | YES | YES |
| GNSS | GPS+GLONASS | GPS+GLONASS | GPS, GLONASS, BeiDou, Galileo, QZSS |
| Firmware Upgrade | USB interface and DFOTA | USB interface and DFOTA | USB interface and DFOTA ³⁾ |

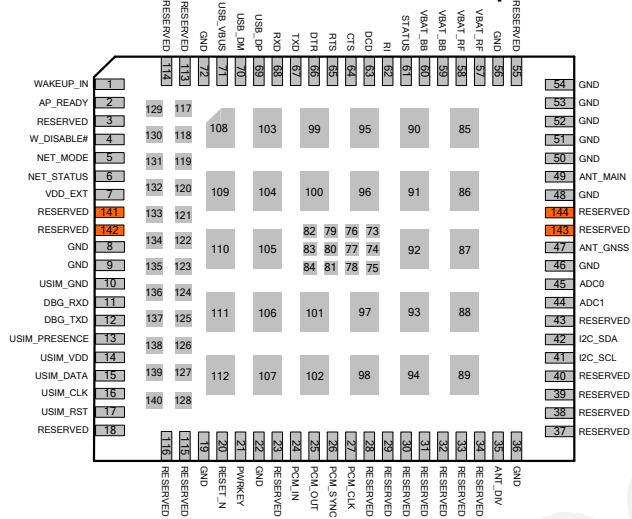
NOTES

- 1) Within operating temperature range, the module is 3GPP compliant.
- 2) Within extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, emergency call, etc. There is no unrecoverable malfunction; there are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operating temperature levels, the module is compliant with 3GPP specification again.
- 3) This function is under development.

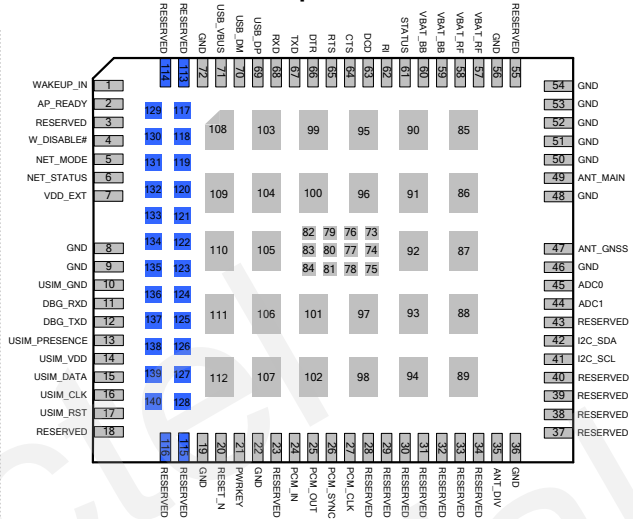
2.3. Pin Assignment

The following figures show the pin assignment of EC25, EC21, EC20 R2.0, EC20 and UC20.

EC25/EC21/EC20 R2.0 Top View



EC20 Top View



UC20 Top View

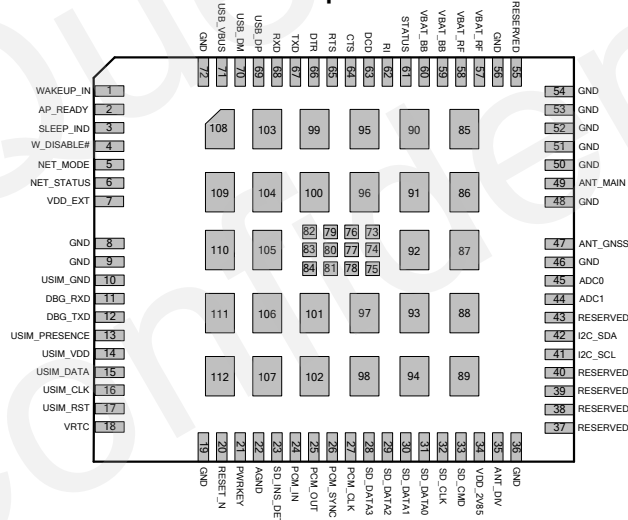


Figure 1: EC2x&UC20 Pin Assignment

NOTES

1. The orange pins are the additional pins of EC25/EC21/ EC20 R2.0 as compared with EC20.
2. The blue pins are the additional pins of EC20 as compared with UC20.

3 Pin Description

This chapter describes the pin definition of EC25, EC21, EC20 R2.0, EC20 and UC20.

Table 4: I/O Parameters Definition

| Symbol | Description |
|--------|----------------------------|
| AI | Analog Input |
| AO | Analog Output |
| DI | Digital Input |
| DO | Digital Output |
| IO | Bidirectional Input/Output |
| OD | Open Drain |
| PI | Power Input |
| PO | Power Output |

3.1. Common Pins

The following table shows EC25, EC21, EC20 R2.0, EC20 and UC20's common pins with the same function.

Table 5: Common Pins

| EC2x | | | | UC20 | | | |
|---------|-----------|-----|--------------|---------|-----------|-----|--------------|
| Pin No. | Pin Name | I/O | Power Domain | Pin No. | Pin Name | I/O | Power Domain |
| 1 | WAKEUP_IN | DI | 1.8V | 1 | WAKEUP_IN | DI | 1.8V |

| | | | | | | | |
|----|---------------|----|----------|----|---------------|----|----------|
| 2 | AP_READY | DI | 1.8V | 2 | AP_READY | DI | 1.8V |
| 4 | W_DISABLE# | DI | 1.8V | 4 | W_DISABLE# | DI | 1.8V |
| 5 | NET_MODE | DO | 1.8V | 5 | NET_MODE | DO | 1.8V |
| 6 | NET_STATUS | DO | 1.8V | 6 | NET_STATUS | DO | 1.8V |
| 7 | VDD_EXT | PO | 1.8V | 7 | VDD_EXT | PO | 1.8V |
| 8 | GND | - | Ground | 8 | GND | - | Ground |
| 9 | GND | - | Ground | 9 | GND | - | Ground |
| 10 | USIM_GND | - | Ground | 10 | USIM_GND | - | Ground |
| 11 | DBG_RXD | DI | 1.8V | 11 | DBG_RXD | DI | 1.8V |
| 12 | DBG_TXD | DO | 1.8V | 12 | DBG_TXD | DO | 1.8V |
| 13 | USIM_PRESENCE | DI | 1.8V | 13 | USIM_PRESENCE | DI | 1.8V |
| 14 | USIM_VDD | PO | 1.8/3.0V | 14 | USIM_VDD | PO | 1.8/3.0V |
| 15 | USIM_DATA | IO | 1.8/3.0V | 15 | USIM_DATA | IO | 1.8/3.0V |
| 16 | USIM_CLK | DO | 1.8/3.0V | 16 | USIM_CLK | DO | 1.8/3.0V |
| 17 | USIM_RST | DO | 1.8/3.0V | 17 | USIM_RST | DO | 1.8/3.0V |
| 19 | GND | - | Ground | 19 | GND | - | Ground |
| 20 | RESET_N | DI | 1.8V | 20 | RESET_N | DI | 1.8V |
| 21 | PWRKEY | DI | 1.8V | 21 | PWRKEY | DI | 1.8V |
| 22 | GND | - | Ground | 22 | AGND | - | Ground |
| 23 | RESERVED | - | - | 23 | RESERVED | - | - |
| 24 | PCM_IN | DI | 1.8V | 24 | PCM_IN | DI | 1.8V |
| 25 | PCM_OUT | DO | 1.8V | 25 | PCM_OUT | DO | 1.8V |
| 26 | PCM_SYNC | IO | 1.8V | 26 | PCM_SYNC | IO | 1.8V |
| 27 | PCM_CLK | IO | 1.8V | 27 | PCM_CLK | IO | 1.8V |
| 28 | RESERVED | - | - | 28 | RESERVED | - | - |
| 29 | RESERVED | - | - | 29 | RESERVED | - | - |

| | | | | | | | |
|----|----------|----|------------------|----|----------|----|-----------|
| 30 | RESERVED | - | - | 30 | RESERVED | - | - |
| 31 | RESERVED | - | - | 31 | RESERVED | - | - |
| 32 | RESERVED | - | - | 32 | RESERVED | - | - |
| 33 | RESERVED | - | - | 33 | RESERVED | - | - |
| 34 | RESERVED | - | - | 34 | RESERVED | - | - |
| 35 | ANT_DIV | AI | - | 35 | ANT_DIV | AI | - |
| 36 | GND | - | Ground | 36 | GND | - | Ground |
| 37 | RESERVED | - | - | 37 | RESERVED | - | - |
| 38 | RESERVED | - | - | 38 | RESERVED | - | - |
| 39 | RESERVED | - | - | 39 | RESERVED | - | - |
| 40 | RESERVED | - | - | 40 | RESERVED | - | - |
| 41 | I2C_SCL | OD | 1.8V only | 41 | I2C_SCL | OD | 1.8V only |
| 42 | I2C_SDA | OD | 1.8V only | 42 | I2C_SDA | OD | 1.8V only |
| 43 | RESERVED | - | - | 43 | RESERVED | - | - |
| 44 | ADC1 | AI | 0.3V~ VBAT_BB | 44 | ADC1 | AI | 0.2~4.2V |
| 45 | ADC0 | AI | 0.3V~ VBAT_BB | 45 | ADC0 | AI | 0.2~2.1V |
| 46 | GND | - | Ground | 46 | GND | - | Ground |
| 47 | ANT_GNSS | AI | - | 47 | ANT_GNSS | AI | - |
| 48 | GND | - | Ground | 48 | GND | - | Ground |
| 49 | ANT_MAIN | IO | - | 49 | ANT_MAIN | IO | - |
| 50 | GND | - | Ground | 50 | GND | - | Ground |
| 51 | GND | - | Ground | 51 | GND | - | Ground |
| 52 | GND | - | Ground | 52 | GND | - | Ground |
| 53 | GND | - | Ground | 53 | GND | - | Ground |
| 54 | GND | - | Ground | 54 | GND | - | Ground |
| 55 | RESERVED | - | - | 55 | RESERVED | - | - |

| | | | | | | | |
|--------|----------|----|----------|--------|----------|----|----------|
| 56 | GND | - | Ground | 56 | GND | - | Ground |
| 57 | VBAT_RF | PI | 3.3~4.3V | 57 | VBAT_RF | PI | 3.3~4.3V |
| 58 | VBAT_RF | PI | 3.3~4.3V | 58 | VBAT_RF | PI | 3.3~4.3V |
| 59 | VBAT_BB | PI | 3.3~4.3V | 59 | VBAT_BB | PI | 3.3~4.3V |
| 60 | VBAT_BB | PI | 3.3~4.3V | 60 | VBAT_BB | PI | 3.3~4.3V |
| 61 | STATUS | OD | - | 61 | STATUS | OD | - |
| 62 | RI | DO | 1.8V | 62 | RI | DO | 1.8V |
| 63 | DCD | DO | 1.8V | 63 | DCD | DO | 1.8V |
| 64 | CTS | DO | 1.8V | 64 | CTS | DO | 1.8V |
| 65 | RTS | DI | 1.8V | 65 | RTS | DI | 1.8V |
| 66 | DTR | DO | 1.8V | 66 | DTR | DI | 1.8V |
| 67 | TXD | DI | 1.8V | 67 | TXD | DO | 1.8V |
| 68 | RXD | DI | 1.8V | 68 | RXD | DI | 1.8V |
| 69 | USB_DP | IO | - | 69 | USB_DP | IO | - |
| 70 | USB_DM | IO | - | 70 | USB_DM | IO | - |
| 71 | USB_VBUS | PI | Typ. 5V | 71 | USB_VBUS | PI | Typ. 5V |
| 72 | GND | - | Ground | 72 | GND | - | Ground |
| 73~84 | RESERVED | - | - | 73~84 | RESERVED | - | - |
| 85~112 | GND | - | Ground | 85~112 | GND | - | Ground |

3.2. Different Pins

The following table shows the different functional pins of EC25, EC21, EC20 R2.0, EC20 and UC20.

Table 6: Different Functional Pins between EC2x and UC20

| EC2x | | | | UC20 | | | |
|---------|----------|-----|--------------|---------|-----------|-----|--------------|
| Pin No. | Pin Name | I/O | Power Domain | Pin No. | Pin Name | I/O | Power Domain |
| 3 | RESERVED | - | - | 3 | SLEEP_IND | DO | 1.8V |
| 18 | RESERVED | - | - | 18 | VRTC | IO | 1.5~3.25V |
| 113~140 | RESERVED | - | - | | | | |

The following table shows the additional pins of EC25/EC21/EC20 R2.0 as compared with EC20.

Table 7: Additional Pins of EC25/EC21/EC20 R2.0 vs EC20

| PIN No. | Pin Name | I/O | Pin Description |
|---------|----------|-----|-----------------|
| 141~144 | RESERVED | - | - |

NOTES

1. Keep all reserved and unused pins unconnected.
2. All GND pins should be connected to ground.

4 Hardware Reference Design

4.1. Power Supply

The power supply range of EC25, EC21, EC20 R2.0, EC20 and UC20 is from 3.3V to 4.3V. Attention should be paid to the range of power source to make sure that the input voltage will never drop below 3.3V or exceed 4.3V. The typical power supply is 3.8V. The following figure shows a reference design for a 5V input power source. The designed output for the power supply is 3.88V and the maximum load current is 3A. The VBAT_BB and VBAT_RF pins should be divided into two separated paths in star structure. In addition, in order to get a stable output voltage, it is suggested to use a zener diode whose reverse zener voltage is 5.1V and dissipation power is more than 0.5 watt.

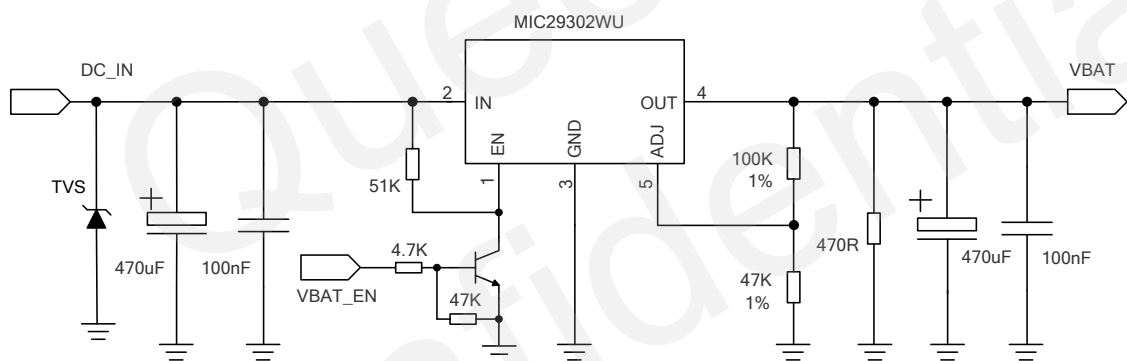


Figure 2: Reference Circuit of Power Supply

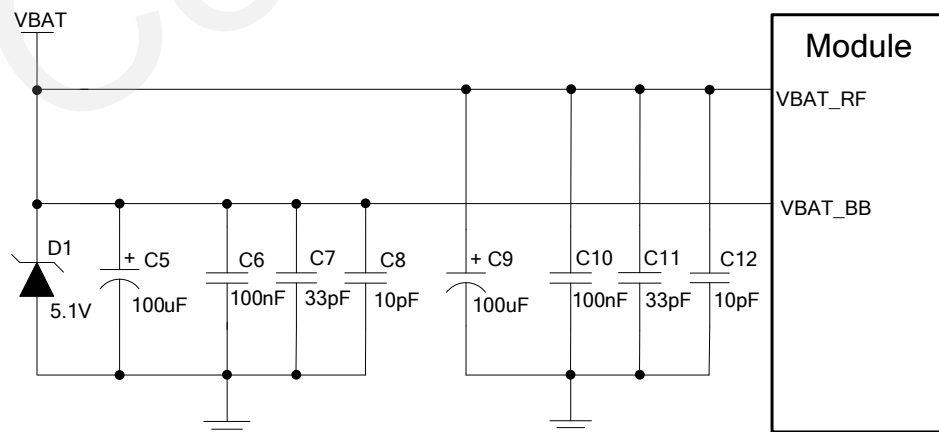


Figure 3: Reference Circuit of Star Structure

4.2. Power on and off Circuit

The following is a reference design for EC25, EC21, EC20 R2.0, EC20 and UC20's power on and off circuit.

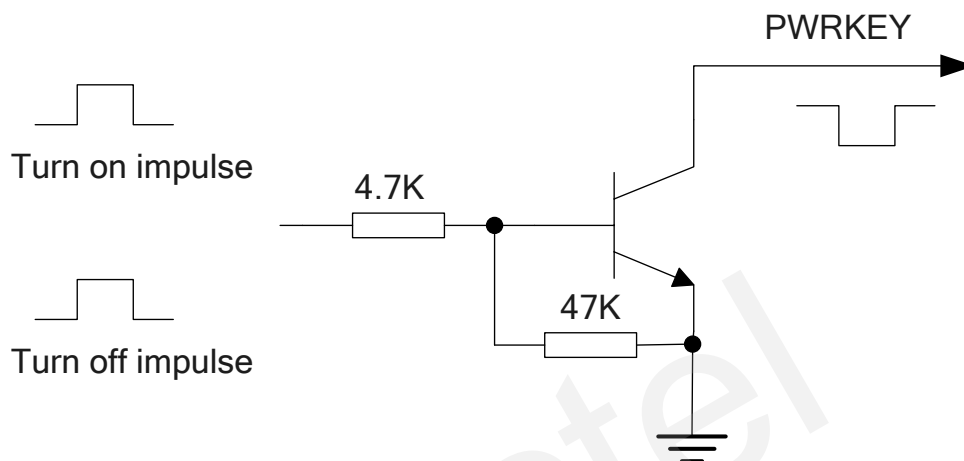


Figure 4: Turn on and off the Module Using Driving Circuit

4.3. Reset Circuit

When it is failed to turn off the module by both command **AT+QPOWD** and PWRKEY pin, the RESET_N can be used to reset the module. The following is a reference design for EC25, EC21, EC20 R2.0, EC20 and UC20's reset circuit.

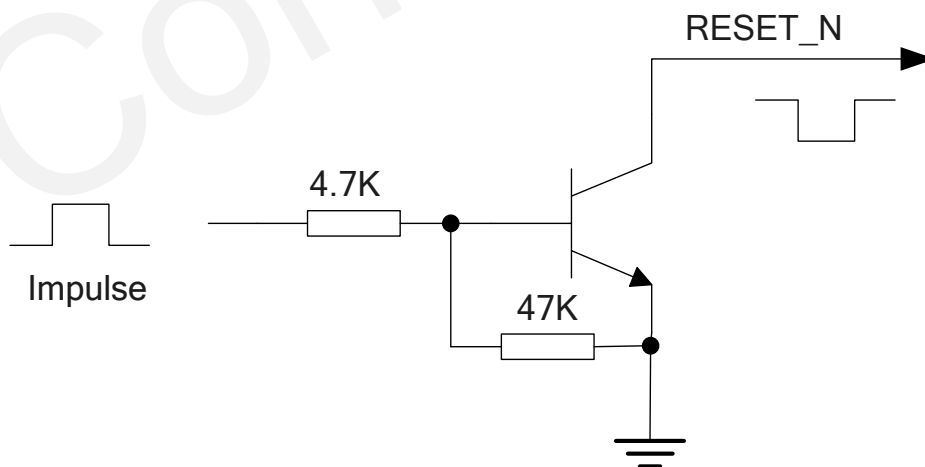


Figure 5: Reset the Module Using Driving Circuit

4.4. USIM Interface

The USIM interface of EC25, EC21, EC20 R2.0, EC20 and UC20 supports 1.8V or 3.0V USIM/SIM cards. A reference circuit for an 8-pin USIM card holder is illustrated below.

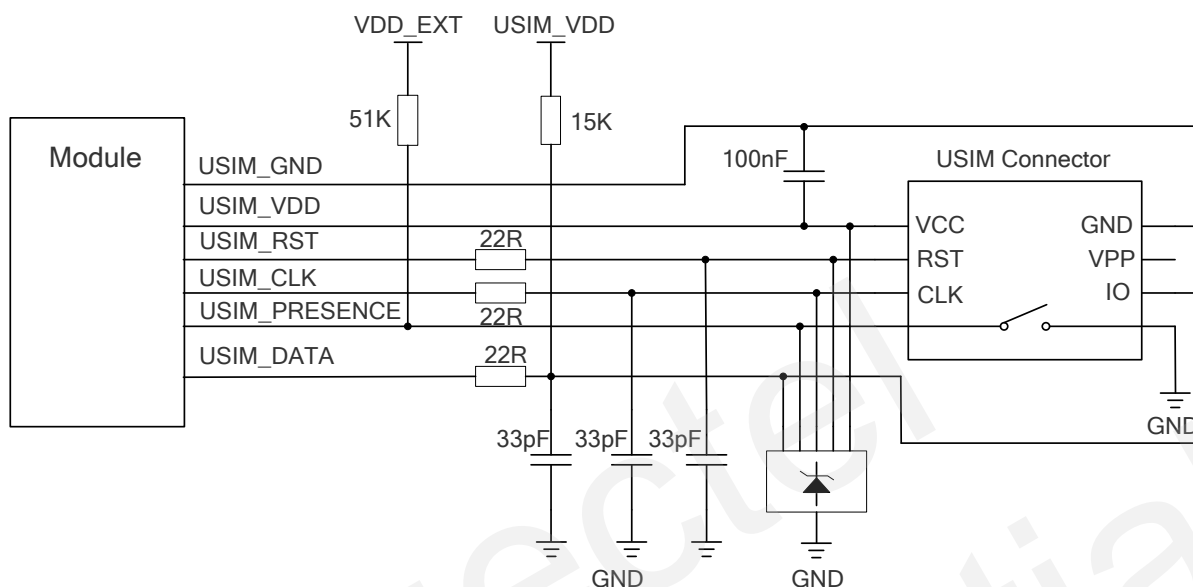


Figure 6: Reference Circuit for an 8-Pin USIM Card Holder

If you do not need the USIM card detection function, keep USIM_PRESENCE unconnected. A reference circuit for a 6-pin USIM card holder is illustrated as the following figure.

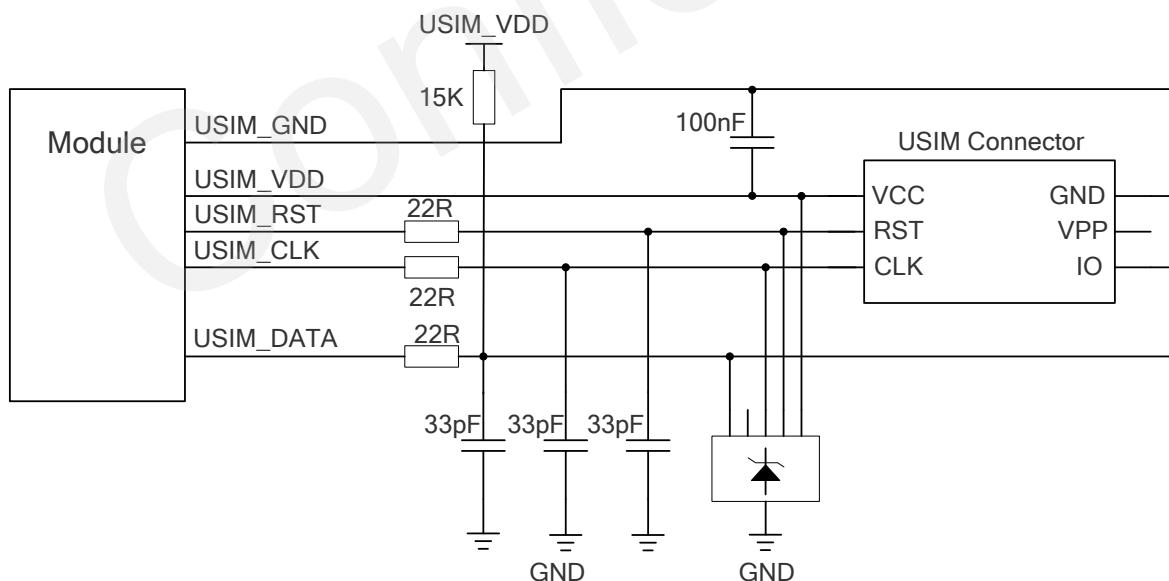


Figure 7: Reference Circuit for a 6-Pin USIM Holder

4.5. USB Application

EC25, EC21, EC20 R2.0, EC20 and UC20 all contain one integrated Universal Serial Bus (USB) transceiver meeting USB 2.0 specification, and support high-speed (480Mbps) and full-speed (12Mbps) modes; UC20 can additionally support low-speed (1.5Mbps) mode. The USB interface can be used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging and firmware upgrade.

The USB interface is recommended to be reserved for firmware upgrade in your design. The following figure shows the reference circuit of USB interface.

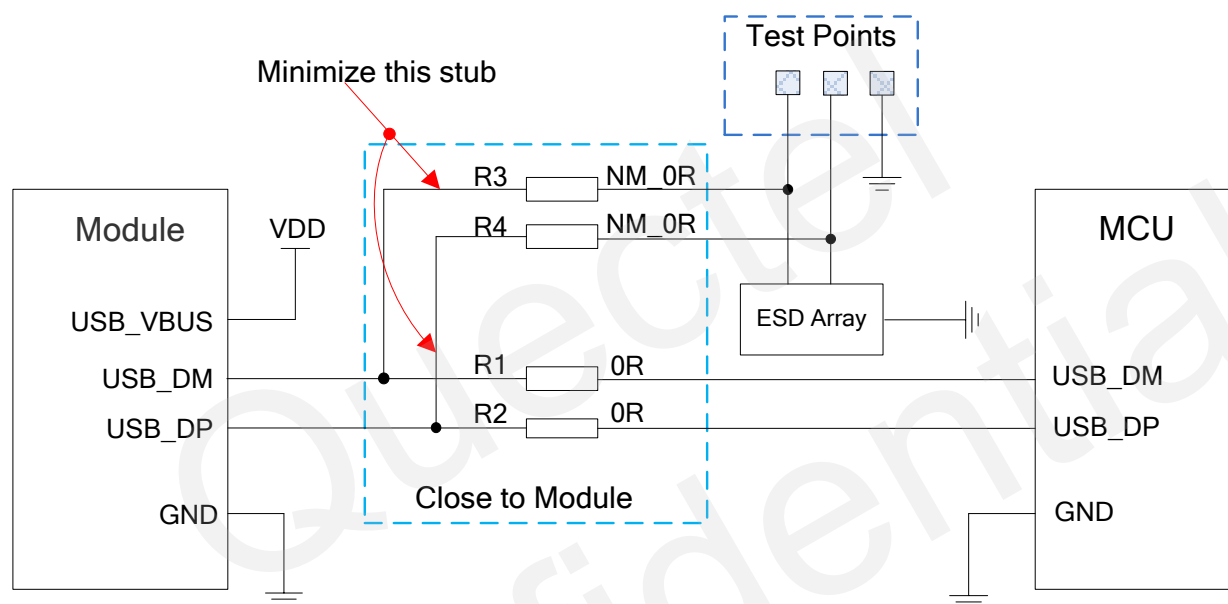


Figure 8: Reference Circuit of USB Application

In order to meet USB data line signal integrity, components R1, R2, R3 and R4 must be placed close to the module, and then these resistors should be placed close to each other as well. The extra stubs of trace must be as short as possible.

NOTE

EC25, EC21, EC20 R2.0, EC20 and UC20 modules can only be used as a slave device.

4.6. PCM Application

EC25, EC21, EC20 R2.0, EC20 and UC20 support one PCM interface used for audio applications with the same feature. The following figure shows a reference design of PCM interface with external codec IC.

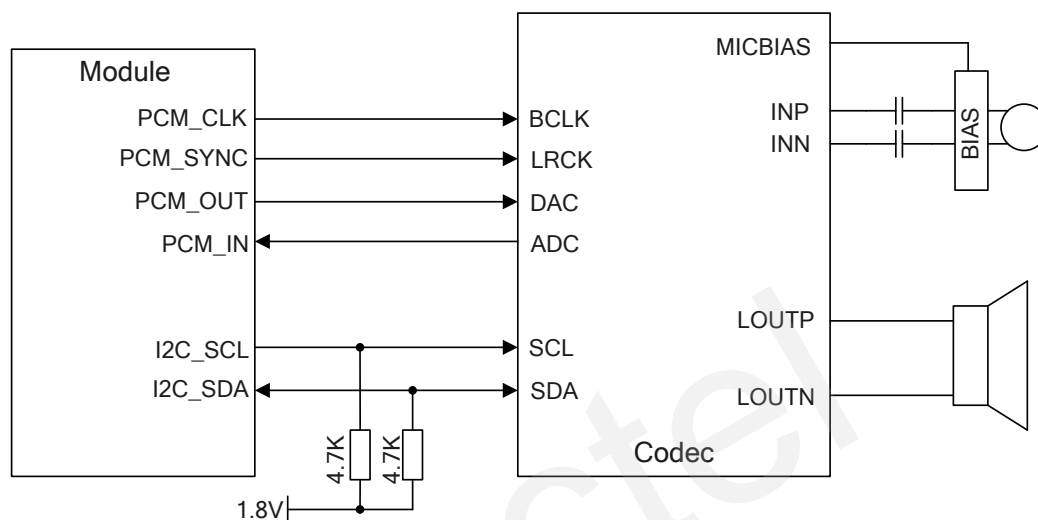


Figure 9: Reference Circuit of PCM Application with Audio Codec

NOTE

It is recommended to reserve the RC (R=22ohm, C=22pF) circuit on the PCM lines, especially for PCM_CLK.

4.7. UART Interface

EC25, EC21, EC20 R2.0, EC20 and UC20 support a main UART and a debug UART interface. The main UART interface can be used for data transmission, AT command communication and firmware upgrade; the debug UART interface can be used for GNSS NMEA sentences output.

EC25, EC21, EC20 R2.0, EC20 and UC20 modules provide 1.8V UART interface. A level translator should be used if your application is equipped with a 3.3V UART interface. Level translator TXS0108EPWR provided by **Texas Instrument** is recommended. The following figure shows a reference design.

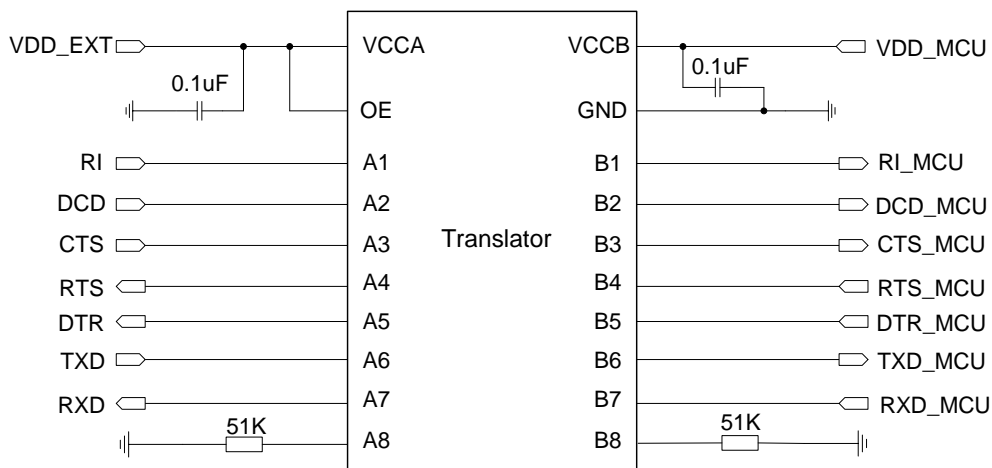


Figure 10: Reference Circuit with Level Translator Chip

Please visit <http://www.ti.com> for more information.

Another example with transistor translation circuit is shown as below. The circuit design of dotted line section can refer to the design of solid line section, in terms of both module input and output circuit designs; but please pay attention to the direction of connection.

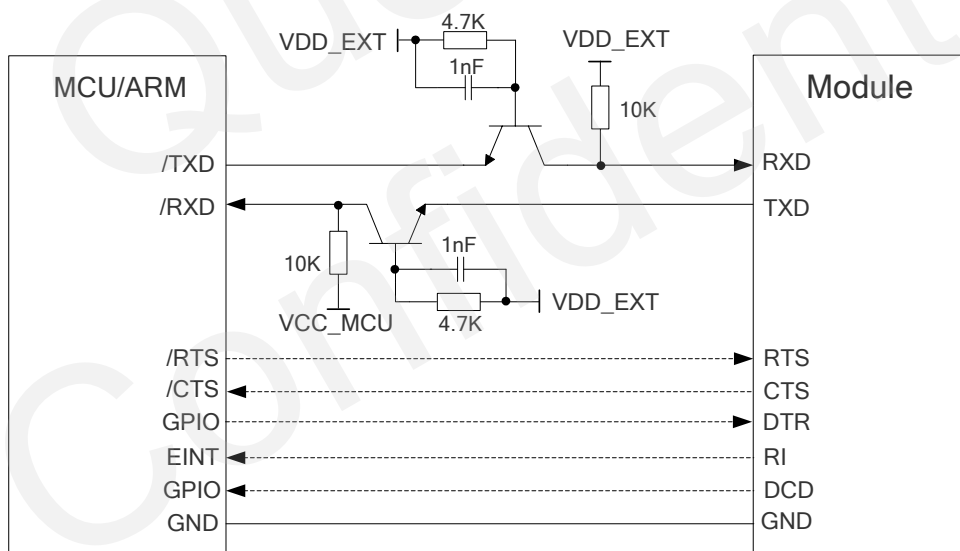


Figure 11: Reference Circuit with Transistor Circuit

NOTE

Transistor circuit solution is not suitable for applications with high baud rate exceeding 460Kbps.

4.8. Antenna Interface

EC25, EC21, EC20 R2.0, EC20 and UC20 have the same antenna interfaces: ANT_MAIN, ANT_GNSS and ANT_DIV. For better RF performance, a π -type matching circuit should be reserved. The following figure shows a reference circuit.

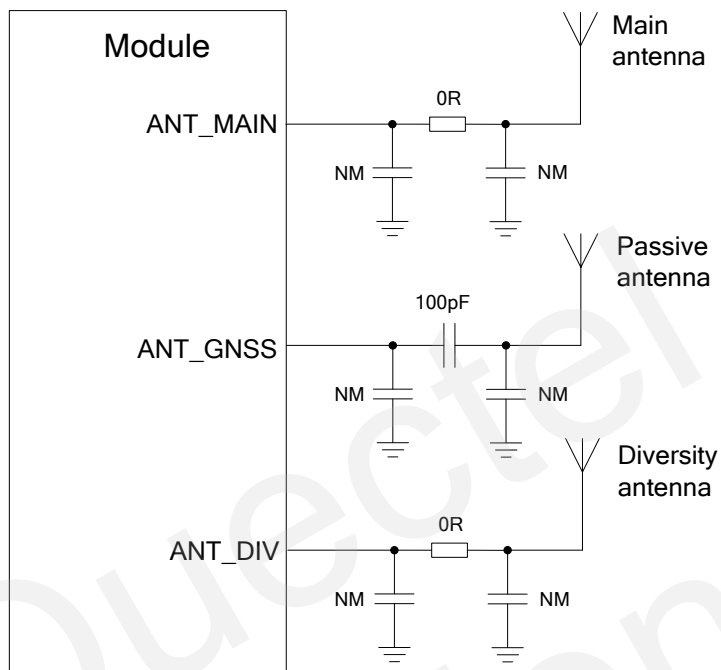


Figure 12: Reference Circuit of Antenna Interface

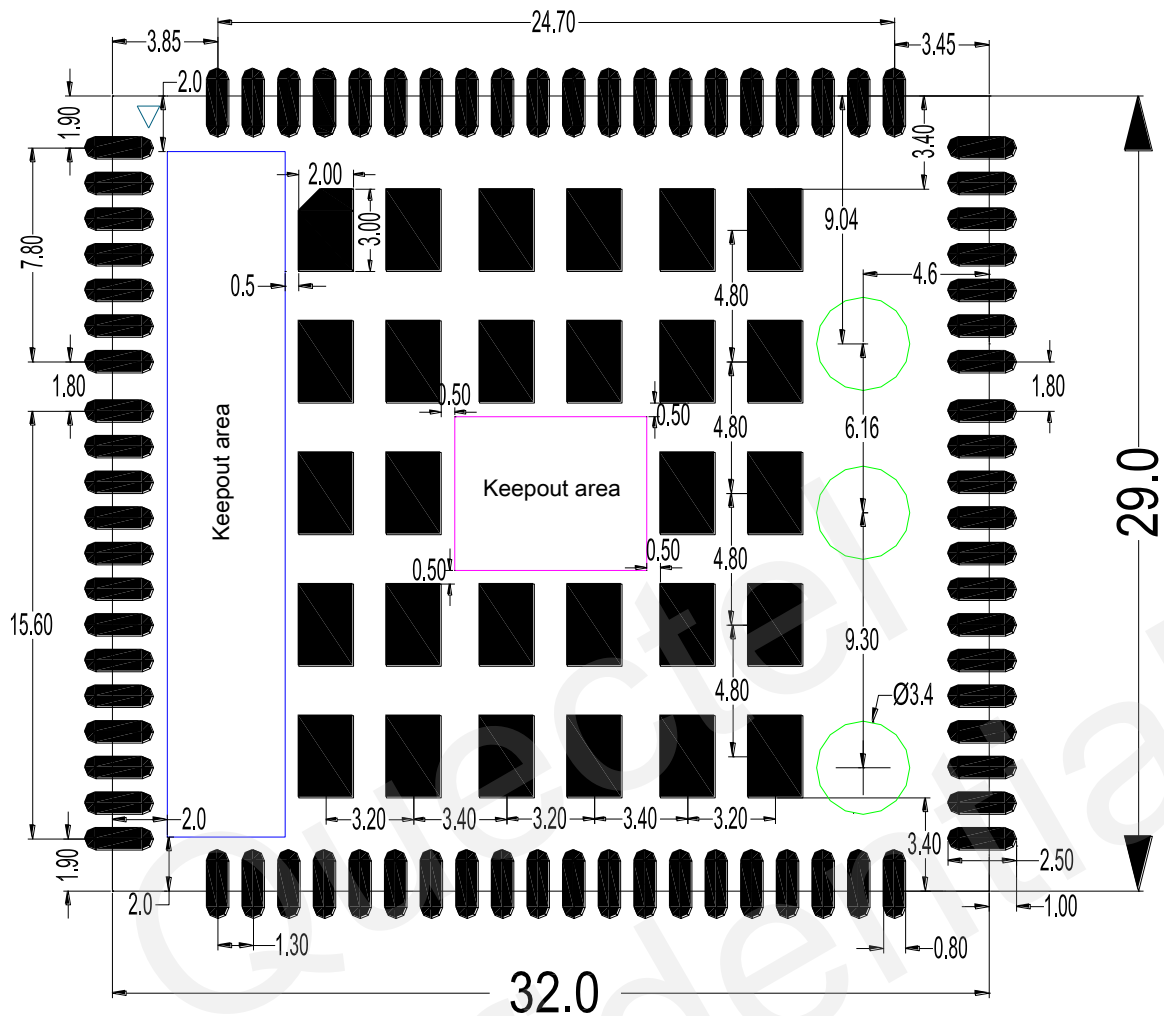


Figure 14: Recommended Compatible Footprint without SGMII or Wi-Fi (Unit: mm)

NOTES

1. The purple red area should be kept out.
2. It is recommended to keep out the blue area for pins 117~140, if SGMII or Wi-Fi function is not needed.
3. When it concerns to compatible design with UC20, the three round green areas should be kept out.
4. For convenient maintenance of the module, keep about 3mm between the module and other components in the host PCB.

The following figure shows the sketch map of installation among EC25, EC21, EC20 R2.0, EC20 and UC20.

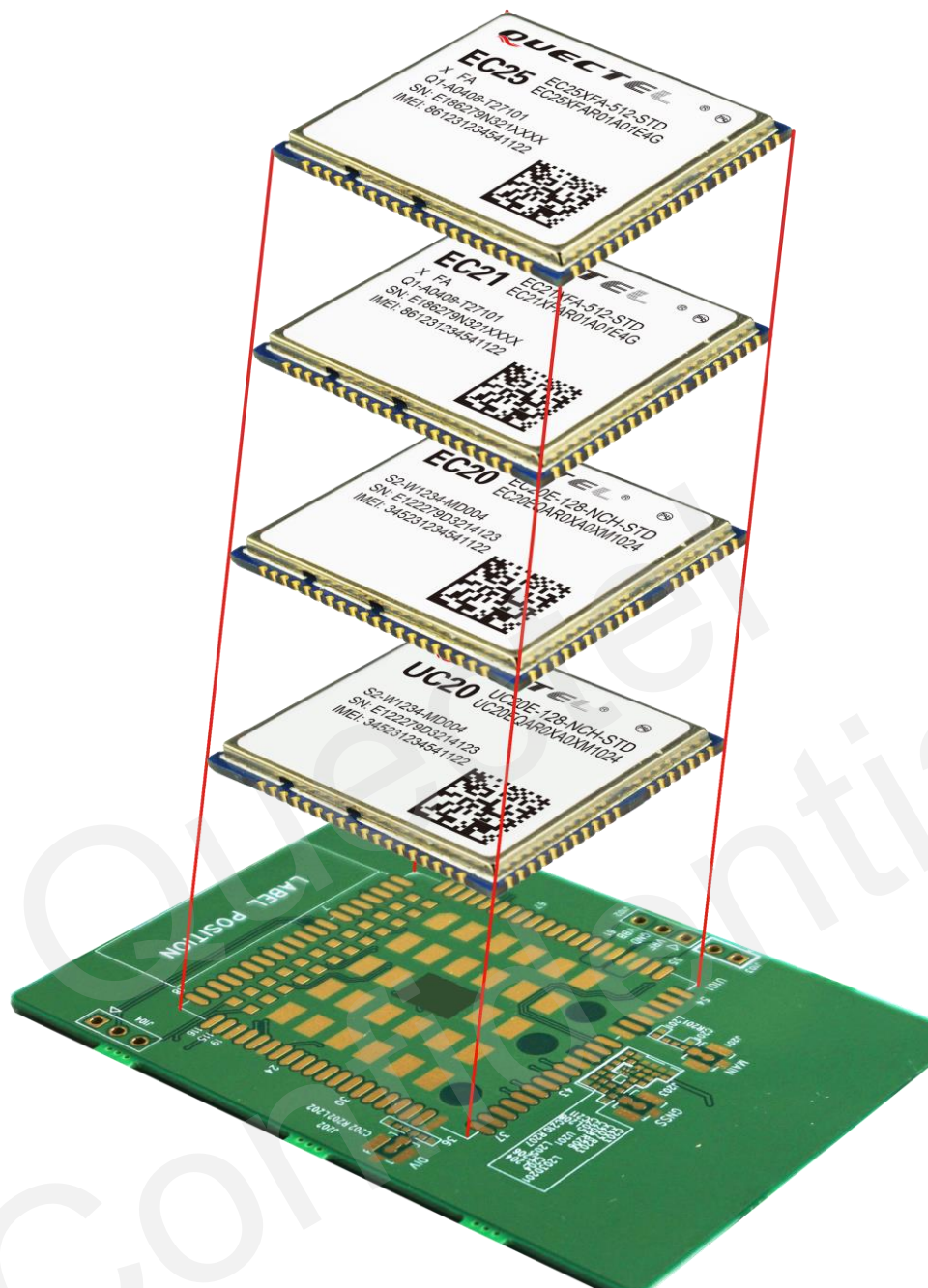


Figure 15: Installation Sketch Map for ECxx and UC20

6 Appendix References

Table 8: Related Documents

| SN | Document Name | Remark |
|-----|------------------------------------|----------------------------|
| [1] | Quectel_UC20_Hardware_Design | UC20 Hardware Design |
| [2] | Quectel_EC20_Hardware_Design | EC20 Hardware Design |
| [3] | Quectel_EC25_Hardware_Design | EC25 Hardware Design |
| [4] | Quectel_EC20 R2.0_Hardware_Design | EC20 R2.0 Hardware Design |
| [5] | Quectel_UC20_Reference_Design | UC20 Reference Design |
| [6] | Quectel_EC20_Reference_Design | EC20 Reference Design |
| [7] | Quectel_EC25_Reference_Design | EC25 Reference Design |
| [8] | Quectel_EC20 R2.0_Reference_Design | EC20 R2.0 Reference Design |